

**SMOOTHING IMPLEMENTATION OF A NEW  
800 MHz DIGITAL RADIO SYSTEM**

Strategic Management of Change

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An applied research project submitted to the National Fire Academy  
as part of the Executive Fire Officer Program

February 2002

## **ABSTRACT**

“Communications is our single, most important job tool” (Morgan, 1997, p. 115).  
“Inadequate communication has a definite negative impact on the safety of emergency personnel and may contribute to injuries or deaths of firefighters, rescue workers, and civilians” (Thiel and Stambaugh, 1999, p. 2).

The problem is that the Prince William County Department of Fire and Rescue (PWCDFR) and its volunteer agencies are about to implement an 800 MHz digital, trunked radio system without the benefit of understanding the key issues necessary for success. The purpose of this research project was to develop a checklist of key issues and strategies that will enhance the likelihood of a successful implementation of the new 800 MHz radio system. This research project employed historical, evaluative and action research methodologies to answer the following questions:

1. What are the operational differences between the current 154 MHz radio system and the new 800 MHz system?
2. What successful strategies and pitfalls have been encountered by other fire departments implementing 800 MHz systems?
3. What key issues and strategies must the PWCDFR employ to assure a smooth implementation of the new 800 MHz radio system?

Research was conducted into 800 MHz radio operations, firefighter fatalities, and adult learning. This research was used in identifying components for a checklist to guide the implementation of the new 800 MHz radio system. Changes in standard

operational procedures must be made to correlate with the new radio systems functions and operations. Training must be developed to reflect real world uses, based on the Training in Context training model.

Expansion of this study requires a survey of jurisdictions that recently implemented an 800 MHz digital, trunked radio system to identify additional problems and issues they may have encountered. Also, a thorough research of adult learning and change should be initiated to aid in the development of the training program.

## TABLE OF CONTENTS

ABSTRACT .....	2
TABLE OF CONTENTS .....	4
INTRODUCTION.....	5
BACKGROUND AND SIGNIFICANCE.....	6
LITERATURE REVIEW.....	8
800 MHz radio System .....	8
Communications Contributing Factors in Fatalities.....	12
Adult Learning and Change .....	16
PROCEDURES.....	17
Definition of Terms.....	18
Research Methodology.....	19
Literature Review.....	19
Assumptions and Limitations .....	20
RESULTS.....	21
Answers to Research Questions.....	21
DISCUSSION.....	26
RECOMMENDATIONS.....	29
REFERENCES.....	32
APPENDIX 1 - Checklist for Implementing 800 MHZ Radio System.....	35

## INTRODUCTION

“Communications is our single, most important job tool” (Morgan, 1997, p.115). “Inadequate communication has a definite negative impact on the safety of emergency personnel and may contribute to injuries or deaths of firefighters, rescue workers, and civilians” (Thiel and Shambaugh, 1999, p. 2). The gravity of failed or flawed communications is evidenced in several firefighter fatality reports where communications problems are cited as contributory factors.

Radio communication is one of the most important functions on the fireground. When situations arise on the fireground, radio transmissions need to be clear and timely (National Institute of Occupational Safety and Health [NIOSH] 99F-48, 2000). Fire and emergency medical providers rely heavily on the performance capabilities of the communications system. “Communications problems are considered the most common operational snag in the majority of departments, effecting the firefighters’ ability to start, coordinate, and complete effective operations” (Brunacini, 1985, p. 54).

The problem is that the Prince William County Department of Fire and Rescue (PWCDFR) and its volunteer agencies are about to implement an 800 MHz digital, trunked radio system without the benefit of understanding the key issues necessary for success. The purpose of this research project was to develop a checklist of key issues and strategies that will enhance the likelihood of a successful implementation of the new 800 MHz radio system. This research project employed historical, evaluative and action research methodologies to answer the following questions:

1. What are the operational differences between the current 154 MHz radio system and the new 800 MHz system being installed?
2. What successful strategies and pitfalls have been encountered by other fire departments implementing 800 MHz systems?
3. What key issues and strategies must the PWCDFR employ to assure a smooth implementation of the new 800 MHz radio system?

### **BACKGROUND AND SIGNIFICANCE**

Prince William County is located in Northern Virginia approximately 35 miles southwest of Washington, D. C. It encompasses an area of 348 square miles. As of December 2001, the estimated population of the County was 303,477. The County has experienced rapid growth, growing 99.3% between 1980 and 2000. (Prince William County [PWC], 2001)

The Prince William County fire and rescue service is comprised of the PWCDFR and 12 independent volunteer fire and rescue departments. Collectively, the chiefs of these departments and two additional members of the Department of Fire and Rescue make up the membership of the Prince William County Fire and Rescue Association Board of Directors who provide the leadership and vision for the future of fire protection and EMS services.

Prince William County's fire and rescue services is provided by a combination career and volunteer system, which is comprised of 805 active volunteer members and

264 career department members of which 241 are uniformed personnel (Strawderman, 2000). The volunteer fire and rescue companies operate 17 fire/rescue stations.

Career personnel staff the 17 stations Monday through Friday from 6 a.m. to 6 p.m. In addition, career personnel staff four 24-hour Advanced Life Support medic units seven days a week and two personnel staff a suppression unit at one station 24-hours-a-day, 7-days-a-week. Volunteers staff the stations during all other times Monday through Friday nights and on weekends and holidays. (Prince William County Fire and Rescue Association [PWCFRA], 1998)

Total fire and rescue incidents have continually increased in correlation with the population growth. Between fiscal years 1989 and 1999 emergency incidents increased 25.7% from 17,440 to 23,480. During this same period, the population grew from 211,064 to 279,845, a 24.6% increase. (Strawderman, 2000)

Separate from the Department of Fire and Rescue but integral to fire and rescue service, is the Public Safety Communications Center (PSCC). The PSCC is under the direction of the County Executive; however it is managed and administered jointly by the police chief and the PWCDFR chief. The PSCC is a consolidated police and fire/rescue entity that takes policy direction from both parent organizations. The consolidation of independent police and fire/rescue dispatch centers took place in 1996.

This research is directly linked to portions of the National Fire Academy's Strategic Management of Change course, which is a required second year course in the

Executive Fire Officer program (EFOP). The research purpose of developing a checklist of key issues and strategies that will enhance the likelihood of a successful implementation of the new 800 MHz radio system is related to Module 3 in the student manual that dealt with Managing Change Using the Change Management Model. (National Fire Academy [NFA], 1996)

## **LITERATURE REVIEW**

The literature review examines the various factors associated with an 800 MHz radio system, contributing factors to firefighter fatalities, adult learning, and change.

### **800 MHz radio System**

Trunked 800 MHz radio systems have been serving the US fire service for over 30 years now, but there are still conflicting reports on the effectiveness of these systems. The technology is well proven. The difference lies in the effectiveness with which these systems have been planned and implemented. (B. McPherson, Personal communication, January 23, 2002)

Delaware instituted a statewide 800 MHz radio system, but the design has been noted to be lacking. Numerous problems have been reported since the system's installation in 1999. At one fire, about six firefighters were trying to send a message saying they were trapped on the second floor of a house fire, but no one could understand them. "Communication was absolutely terrible ... terrible," said Claymont Fire Company spokesman Jacob Morente. (Bailey and O'Sullivan, 2001)



There are significant differences between the radio propagation characteristics of 150 MHz VHF and 800 MHz systems. In general, VHF broadcasts well over open areas and is capable of filling in the hills and valleys with only a few tower transmitter sites. 800 MHz, on the other hand, does not cover open terrain as far, but will cover the interiors of buildings better than 150 MHz VHF systems. Given a greater density of sites, and using advanced simulcast and multicast technologies, 800 MHz can accomplish both open space coverage and building penetration, for a total wide-area radio solution. (McPherson, 2001)

The operational differences are related more to the use of trunking operations than the frequency range of the system. These operational differences are related to how users access and acquire channel assignments, rather than the frequency band used. Trunking provides a group of frequencies that are automatically assigned by computer to pre-defined groups of users (talkgroups). The current 154 MHz system is a conventional operation system in which specific channels are permanently assigned to particular user groups. In conventional systems, the number of available resources for any user group is limited by the fixed assignments of available channels. The most prominent operational difference is in the number of available talkgroups available. In a trunked system, many more talkgroups rather than frequency channels can be made available, due to the fact that not all users attempt to use the system at the same time. (McPherson, 2001)

As Sando and O'Hara (1997, p. 117) commented:

...a digital system is not a remedy for whatever ails your current analog system either . . . . System designers, operators and users must all develop a clear and thorough understanding of the differences in how analog and digital systems operate. Digital system design and performance differ considerably from analog systems. Much of your analog experience does not apply.

Trunking systems offer a wide range of features not available on conventional systems. These features include emergency signaling, multiple access priorities, busy signaling, queuing, callback, central system management, and a whole range of advanced features made possible through computer signaling and access control. (B. McPherson, Personal communication, January 23, 2002) "Using Motorola technology to its fullest will assist performance at every level of system operation" (Motorola, 2001, p. 3).

Although trunking systems employ state of the art sophisticated technology, the actual user operation is simple. Users only need to select the talkgroup they wish to use, and hit the transmit button. The computerized system will automatically assign a channel, verify availability and priority, and regroup the users in a fraction of a second. By contrast, in a conventional system, a user must use a limited number of channels, check for channel activity and hope that all users are within the transmit range. (McPherson, 2001)

Users may expect this new technology to be a perfect solution to all of their radio system problems. Digital systems address only one aspect of radio system performance. Digital technology is not the “silver bullet” that eliminates such things as interference and coverage problems that always have irritated users. (Sando and O’Hara, 1997, p 46)

“Understanding is the key concept. Everyone must understand the technology and the agency or community need. Everyone needs to appreciate that bringing new technology to an agency or organization is a team effort” (Sando and O’Hara, 1997, p. 119).

Good training is critical to insuring successful system implementation. Without training, users will not be able to use the system to its full potential, and will point the finger of blame on the management and the system vendor when they fail to communicate (McPherson, 2001, p. 3).

As Worthington (2001) stated at the 15th Redmond Symposium in his presentation regarding implementing 800 MHz radio systems, “Train Firefighters. Train, train, train.”

Motorola, in its Training Plan document (2001, p. 3) from their Worldwide Learning Services states, “... your equipment is a highly sophisticated communications instrument, and as such, requires specialized training to fully realize the equipment’s

potential.” It also asserts (p. 3), “Receiving the proper training increases your employees’ efficiency in their use of the system.”

Reynolds (1997, p. 114) stated that, “Interoperability was the compelling benefit that convinced the State of Delaware to begin installation of its new statewide digital radio system. The new digital system makes interagency communications possible.”

As digital systems are deployed, user expectations of the new technology become critical in making a smooth transition from analog to digital. In fact, user expectations may be as important to successful implementation as the technology itself. Expectation always is the critical element in shifting from one technology to another. Change requires new ways of thinking. Some users jump at the chance to make the move. Others want to hold on to the familiar technology they already know. (Sando and O’Hara, 1997, p 46)

### **Communications Contributing Factors in Fatalities**

A review of firefighter fatality reports confirms that communications problems are often identified as contributory factors in the death of the firefighters. Below are examples of this problem, several specifically involving 800 MHz radio systems.

#### **Chesapeake, Virginia.**

Two firefighters were killed in an auto parts store in Chesapeake, Virginia on March 18, 1996. The fire originated due to an electrical short circuit and extended

through the void area above the drop ceiling. The two firefighters inside the building became aware that they were in trouble and attempted to radio for assistance. Neither the incident commander nor the communications center received this request for assistance. A responding battalion chief thought he heard the call for help and twice unsuccessfully attempted to contact the incident commander and advise him that he thought firefighters were trapped. Unfortunately, the incident commander did not announce this request for assistance until 19 minutes after the first request. (Isner, n.d.)

The fireground communications at the fire scene became ineffective at times due to all of the radio traffic, dispatch messages and noise at the fire scene. Chesapeake only had two radio channels available for incident scene use. The incident commander, positioned at the front of the store, was not able to receive and understand the emergency transmissions from the firefighters inside the building that were in trouble. (Isner, n.d.)

#### Hackensack, New Jersey.

Five firefighters were killed during a fire at an automobile dealership. The firefighters were operating on the interior of the building in the service/repair area when the truss roof assembly failed due to the extensive fire involvement. There were at least five other firefighters in the building when the collapse occurred. Three firefighters were trapped immediately by the falling building structure and contents. Two firefighters were trapped in a small room, but ran out of air before they could be rescued. (Demers, n.d.)

A major contributing factor of the fatalities was the lack of effective communications. The two firefighters trapped in the room radioed for help seven times, both to the incident commander and the communications center, before there was confirmation of the message by the communications center. The trapped firefighters attempted seven more radio transmissions, a total of 14 attempts, to the incident commander before there was an answer. (Demers, n.d.)

#### Indianapolis, Indiana.

Two Indianapolis firefighters and a hotel guest died in an early morning fire in the Indianapolis Athletic Club and four firefighters were injured. The fire began on the third floor of the nine-story building, spread through combustible concealed spaces and a resulting flash fire claimed the lives of the two firefighters. (Chubb, n.d.)

Communications issues were cited as contributory factors in the deaths and injuries. One firefighter suffered serious burn injuries attempting to activate the emergency notification button on his portable radio. Some officials believed the change to a new 800 MHz radio system only two weeks prior to the incident contributed to the problems. Lack of training and lack of familiarity with radio equipment and procedures were noted as key issues related to the deaths and injuries. (Chubb, n.d.)

#### Missouri.

In December 1999, a Battalion Chief was fatally injured during a fire in a paper warehouse. The fire was located in the paper-bale section of the structure and was

filling the building with a haze of smoke. The Battalion Chief, while enroute, advised the incident commander that they may have radio problems due to past experiences with their 800 MHz trunked radio system in similar type structures. After over 50 minutes of battling the blaze, the incident commander decided conditions had deteriorated to a point where a defensive attack should be utilized. All personnel were ordered to evacuate the structure. (NIOSH, 2000b)

Several firefighters did not receive the evacuation order over their portable radios either due to interference or some other loss of communications. Some of them eventually ran out of air in their self-contained breathing apparatus, became disoriented and needed assistance to exit the building. The Battalion Chief also became disoriented, was not able to get out of the structure and subsequently died of asphyxia and carbon monoxide inhalation. (NIOSH, 2000b)

#### Worcester, Massachusetts.

On December 3, 1999, six career firefighters died after they became lost in a six-floor, maze-like, cold storage and warehouse building while searching for two homeless people and fire extension. Thirty-two minutes into the incident, two firefighters became disoriented and radioed for assistance. While attempting to rescue the two firefighters in need of assistance, four more firefighters became lost in the building. (NIOSH, 2000a)

The fireground communications became ineffective due to the congested radio traffic and inadequate radio equipment. Even though the incident commander asked for the channel to be cleared for emergency traffic only, most radio operators continued to use the channel. The dispatch center made numerous transmissions regarding problems with radio emergency buttons during the incident. (NIOSH, 2000a)

### **Adult Learning and Change**

“Under stress, firefighters will perform as they learned. Based on this premise, the training environment should recreate the context and content of the environment in which firefighters are expected to perform. This is what training in context does” (Crandell, 1993, p. 38).

Crandell (1993, p. 38) asks, then answers the following:

If you were the learner, what would you consider the ideal conditions under which to learn something new?

- A training setting just like the environment you'll experience on the job.
- Clear expectations of what to do and how to do it.
- Lots of practice with an experienced instructor right beside you to coach you and make sure you don't fall into bad habits you'll both have to fix later.

“Some people cling desperately to the past. They battle against change out of a fear of the future, not because of a love of the past” (Pritchett and Pound, 1990, p. 4).



Problems are a natural side effect of the change process. Major change cannot possibly be trouble free. Don't forget that frequently on the road to getting better, things first get a little worse. Typically there is a downturn in effectiveness matched by an increase in problems shortly after a change effort gets underway. (Pritchett and Pound, 1990, p. 17)

We must be willing to alter our technique. Rather than barreling ahead with the same old job behaviors that worked well enough in the past, we must learn new routines. And we must make the necessary shift in our mindset so that our thinking is aligned with the new realities of the work world. (Pritchett and Pound, 1995, p. 11)

"As Vince Lombardi, legendary football coach of the Green Bay Packers, said, "...Practice doesn't make perfect. Perfect practice leads to perfect performance" (Roemmelt, 1995, p. 24) Based on this premise training must be accomplished to replicate the real world environment of fire and rescue work and repetitive training conducted to assure success.

## **PROCEDURES**

The researcher re-evaluated the problem statement that the PWCDFR and its volunteer agencies are about to implement an 800 MHz digital, trunked radio system without the benefit of understanding the key issues necessary for success, and found it

to be clear and comprehensive. The purpose of this research project was to develop a checklist of key issues and strategies that will enhance the likelihood of a successful implementation of the new 800 MHz radio system

### **Definition of Terms**

Digital – encoding of voice data to a series of 0's and 1's for transmission and the resultant decoding of the 0's and 1's with the voice signal reproduced. (PWCDFR, 1996)

Megahertz (MHz) – a unit of frequency equal to one million cycles per second. (Random House, 1998, p. 817)

Propagation – the travel of radio waves through space or a physical medium. (Random House, 1998, p. 1043)

Talkgroups – users set to share voice information over a trunked radio system that are automatically grouped by the computer and allocated to send and receive over a computer arranged frequency. (PWCDFR, 1996)

Training in Context – training in tactical or strategic wholes, not in parts, by re-creating operational conditions as closely as possible (Crandell, 1993, p. 38)

Trunking – a method where individual radio channels are allocated on a demand basis from within a group of combined frequencies. (PWCDFR, 1996)

### **Research Methodology**

The desired outcome of this research was to identify and begin development of a checklist for an effective training program to assure successful implementation of the new 800 MHz radio system within Prince William County. Since communications issues have been identified as contributing factors in many firefighter deaths, the development of a training program is intended to be a proactive measure in an effort to prevent firefighter deaths from occurring in Prince William County.

Historical, evaluative and action research were employed by gathering information, which was applied to the problem of implementing an 800 MHz digital, trunked radio system without the benefit of understanding the key issues necessary for success. Research was also conducted on adult learning and change. These materials were used in identifying criteria and methods to implement a training program for the new communications system. Subsequently, a checklist was developed for implementing the 800 MHz radio system (Appendix A).

### **Literature Review**

Literature searches were initiated at the National Emergency Training Center's Learning Resource Center in November 2001 and January 2002. Searches were also conducted on-line through known web sites and organizations to identify published

documents related to this research. The author's private collections of fire and rescue service publications, as well as Prince William County fire and rescue system documents were also examined. An interview was conducted of Bruce McPherson, a Lead Systems Engineer, with Motorola on January 23, 2002 to aid in understanding the functions and operations of the proposed 800 MHz radio system.

### **Assumptions and Limitations**

An anticipated limitation of the research was that communications systems are a rapidly evolving area due to the influx of newer technology and equipment which results in varied levels of capability and operations. Some organizations are implementing state of the art equipment, while others are still using 1960's or earlier hardware. Therefore, system abilities will vary along with the subsequent procedures for radio operations. Even faced with this limitation, it was assumed that other fire departments and dispatch centers would employ best practices in their communications processes and this information would aid in the research.

The research project was limited by the six-month time limit imposed by the National Fire Academy for the completion of EFOP applied research projects. The time constraints impeded a more comprehensive literature review of the total national problem of implementing 800 MHz radio systems. A more thorough research of adult learning and change was also not possible due to the six-month time constraint.

## RESULTS

The overall result of this research is the preliminary checklist of key issues and strategies that will enhance the likelihood of a successful implementation of the new 800 MHz digital, trunked radio system for the Prince William County fire and rescue system. This draft checklist document is shown in Appendix A.

### **Answers to Research Questions**

Research Question 1. What are the operational differences between the current 154 MHz radio system and the new 800 MHz system being installed?

There are significant differences between the radio propagation characteristics of 150 MHz VHF and 800 MHz. In general, VHF propagates well over open areas and fills between hills and valleys with only a few sites. 800 MHz, on the other hand, does not cover open terrain as far, but will cover the interiors of buildings better than VHF. Given a greater density of sites, and using advanced simulcast and multicast technologies, 800 MHz can accomplish both open space coverage and building penetration, for a total wide-area solution that can serve a wide variety of users over entire counties and states. (McPherson, 2001)

The operational differences are related to the use of trunking operation at 800 MHz versus conventional operation at 154 MHz. These operational differences are related to the access and channel assignment methods, rather than the frequency band in use. Trunking provides a common pool of frequencies that are automatically

assigned to pre-defined groups of users (talkgroups). Conventional operation refers to non-trunked operation in which specific channels are permanently assigned to specific user groups. In conventional systems, the number of available resources for any user group is limited by the fixed assignments of available channels. The most prominent operational difference is in the number of available talkgroups available to users. In a trunked system, many more talkgroups than channels can be made available, due to the fact that not all users attempt to access the system at the same time. (McPherson, 2001)

Trunking systems offer a wide range of features not available on conventional systems. These features include emergency signaling, multiple access priorities, busy signaling, queuing, callback, central system management, and a whole range of advanced features made possible through computer signaling and access control. (B. McPherson, Personal communications, January 23, 2002)

Although trunking systems employ very sophisticated technology, the actual user operation is very simple. Users need only select the talkgroup they wish to use, and hit the transmit button. The system will perform automatic channel assignment, verification, and regrouping of users in a fraction of a second. In contrast, in a conventional system, a user must use a limited number of channels, check for channel activity and hope that all users are in range. (McPherson, 2001)

Research Question 2. What successful strategies and pitfalls have been encountered by other fire departments implementing 800 MHz systems?

Based on the experiences of other fire departments and local governments, three strategies to successful planning of new 800 MHz systems have been identified:

1. Properly set the users needs and expectations.
2. Insure the system is properly designed to meet those needs and expectations.
3. Insure that users are properly trained on the new system. (McPherson, 2001)

Early on, the users must be involved in expressing their operational needs regarding such elements as coverage, grade of service, system features, and interoperability. The system planners must properly set realistic user expectations consistent with those needs and with the level of available resources. (Worthington, 2001)

It is important that these needs are converted to operational requirements of the new system. Any attempt to cut corners on requirements will result in disappointment and resultant frustration by the users. For example, installing fewer tower sites than needed will result in coverage holes and dead spots. "This will destroy the users confidence in the system and will only create another horror story. Trunked system vendors can design excellent systems, but only if they are given the latitude to design it

properly without sacrificing long term satisfaction for short term budget savings” (McPherson, 2001).

Finally, good training is critical to insuring successful system implementation. Without training, users will not be able to use the system to its full potential, and will point the finger of blame on the management and the system vendor when they fail to communicate. (B. McPherson, Personal communications, January 23, 2002) “More training should be conducted to develop effective firefighter communication skills. These skills should receive a greater emphasis in training priorities.” (Thiel and Stambaugh, 1999, p. 28)

Effective radio communications is essential to providers of emergency services. Failure of communications causes an unacceptable level of risk to public and personnel safety. If problems exist with systems, equipment, policies, or personnel that compromise our service delivery, they must be corrected. Every person involved in emergency communications provides one link in the chain, and every link must be intact for optimal effectiveness. Agencies must provide high quality training and equipment for users. (Smith, 1997, p. 78)

“Provide training for all personnel involved in communications. Dispatchers, support personnel, everyone from chief to recruit needs to be trained in the proper way to use radios” (Smith, 1997, p. 78).



Research Question 3. What key issues and strategies must the PWCDFR employ to assure a smooth implementation of the new 800 MHz radio system?

As the system is implemented, user training is critically important to instruct and motivate users to operate the radios and the system properly. The transition from analog to digital is as much about people as it is about technology. Users need to be trained to use it effectively because it is different from what they know. Time must be set aside for everyone to get acclimated and comfortable with the way the new system really works. (Sando and O'Hara, 1997, p. 119)

A key issue is to develop a cutover plan from the current radio system to the new 800 MHz system. It is important that a smooth cutover plan be implemented during the transition. The worst mistake that could be made is to hand the users a new trunked radio without a smooth transition plan. Users must have time to get used to the characteristics and operation of the new system before they begin using it in actual operations. The old and new systems should be operated in parallel for a time, until all users are trained and comfortable with the new system. (McPherson, 2001)

An interoperability plan must be developed. One of the most significant features of a trunked radio system is its ability to provide enhanced interoperability in the public safety environment. Interoperability refers to the ability of a communications system to work with neighboring systems in a seamless manner. (McPherson, 2001)

The recent terrorist attack at the Pentagon provided a case study in the benefits of interoperability. Many different fire departments from Northern Virginia and DC were able to interoperate at the scene because of a well-developed interoperability plan. These plans may incorporate both compatible and non-compatible trunked systems, as well as conventional systems in a wide range of frequency bands. (McPherson, 2001)

In the Indianapolis firefighter fatality report, one of the lessons learned focused on familiarity with the communications system, equipment and procedures. As stated in the report:

New radio equipment and lack of familiarity with its operation may have contributed to delays in acknowledging and processing requests for additional companies. If so, these problems illustrate the need for thorough training before, during and after the transition to new radio equipment and procedures. Many departments have found it useful or even necessary to maintain components of their old systems as backups during the early phases of such transitions. (Chubb, 1992)

## **DISCUSSION**

The finding of the literature review confirmed that the planning and training for a new radio system is critical to success. The operational differences create the need for extensive training prior to complete system implementation. Since trunking is a different

method to achieve tactical channels, the operating fire and rescue forces need to understand and practice with the new technology. As was stated by Sando and O'Hara (1997, p. 117), "System designers, operators and users must all develop a clear and thorough understanding of the differences in how analog and digital systems operate. Much of your analog experience does not apply." Even though user operation of a digital trunked radio system is simple, the technology used is very sophisticated (McPherson, 2001). All personnel involved must understand the technology and the organizational needs (Sando and O'Hara, 1997).

Three strategies that must be employed to assure success are:

1. Properly set the users needs and expectations
2. Insure the system is properly designed
3. Insure the users are properly trained. (McPherson, 2001)

"The operational requirements of the system must meet the stated needs of the users. Any attempt to cut corners on requirements will result in disappointment and resultant frustration by the users" (McPherson, 2001).

"The transition to a new digital system from an analog system is as much about the people as it is about the technology" (Sando and O'Hara, 1997, p. 119). The Indianapolis and Missouri firefighter fatalities involved contributing factors that directly related to using a new 800 MHz digital trunked radio system. User training is critically important to assure proper radio and system operations (Sando and O'Hara, 1997).

Cutover and interoperability plans must be developed. As McPherson (Personal communications, January 23, 2002) stated, “The worst mistake that could be made is to hand the users a new trunked radio without a smooth transition plan.” In Michigan their training consists of six hours of training. Four hours’ training are given by Motorola during which the operation and features of the mobile and portable radios are explained. The remaining training time is given by state troopers who detail department radio procedures (Rybicki, 1997). This seems to be a minimal program considering the problems brought forth in this research.

As the fire and rescue services are composed of adults, the plan must adhere to adult learning theories and practices. “Some people cling desperately to the past. They battle against change out of a fear of the future, not because of a love of the past” (Pritchett and Pound, 1990, p. 4). Because of this, a program that addresses the basic learning points created by Crandell must be established. These points are:

- “A training setting just like the environment you’ll experience on the job.
- Clear expectations of what to do and how to do it.
- Lots of practice with an experienced instructor right beside you to coach you and make sure you don’t fall into bad habits you’ll both have to fix later” (Crandell, 1993, p. 38).

As noted above, some of the firefighter fatalities were directly impacted by a new radio system. To assure firefighters know how to react in difficult situations they must

receive adequate and realistic training. “Under stress, firefighters will perform as they learned. Based on this premise, the training environment should recreate the context and content of the environment in which firefighters are expected to perform. This is what training in context does.” (Crandell, 1993, p. 38)

There is a dearth of available literature pertaining to the impact of human factors on effective fireground communication. Furthermore, while fire departments devote substantial time to manipulative skill training, relatively little training is provided to help firefighters develop stress-tempered communication skills. (Thiel and Stambaugh, 1999, p. 3)

Implications of this research are that this project needs to be initiated quickly and a thorough training program must be developed and instituted. A cutover and interoperability plan with both systems being operational for a defined period is a must for continuing safe fire and rescue operations.

## **RECOMMENDATIONS**

The creation of a checklist to aid in employing the new 800 MHz digital, trunked radio system is the first step in what will be an ongoing process to assure successful implementation of the radio system. The training aspect is critical to success. “Without training, users will not be able to use the system to its full potential, and will blame management and the vendor when communications fails” (McPherson, 2001, p. 3). The

training needs to be extensive and replicate real-world scenarios faced by fire and EMS personnel.

Along with custom designed training specific to Prince William County, Motorola offers training which should be included in the training plan. The CENTRACOM Gold Elite Console Training is targeted for dispatchers and the PSCC supervisory personnel (Motorola, 2001). Mobile and portable radio operators should participate in XTS3000 Portable End User training and ASTRO Spectra Mobile Radio End User training (Motorola, 2001).

Existing communication standard operating procedures and practices must be reviewed and adapted to be efficient and effective with the new system. Failure to have or adhere to communications procedures were identified in several of the firefighter fatality reports reviewed in this research. There were noted problems with using newly acquired 800 MHz radio systems. Any problems discovered during installation and training must be investigated immediately and technical resolutions instituted so that radio communications is not lost or impaired in critical situations when the system is operational.

Several recommendations are offered to those interested in performing additional research or implementing a new 800 MHz radio system. First, a survey of jurisdictions that recently implemented a 800 MHz digital, trunked radio system should be conducted to identify problems and issues they may have encountered. This will aid in identifying

specific problem areas. Second, a thorough research of adult learning and change should be initiated to aid in development of the necessary training program.

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## APPENDIX 1

### Checklist for Implementing 800 MHz Radio System

- ☐ Select team members to serve on user design team.
- ☐ User design team establishes needs and expectations.
- ☐ Assure operational requirements are met by system design.
- ☐ Develop technology training program to deliver to users.
- ☐ Develop a cutover plan for system implementation.
- ☐ Develop an interoperability plan, with signed agreements by all agencies.
- ☐ Review and revise standard operating procedures to accommodate 800 MHz.
- ☐ Develop a comprehensive, in context training program.
- ☐ Test system to determine problem areas and issues.
- ☐ Deliver didactic and practical training to all users, noting any identified problems.
- ☐ Allow continuing practice in the field by operational forces prior to start up.
- ☐ Determine and advertise start up date.
- ☐ Start up the 800 MHz system with the current 154 MHz system still operational.
- ☐ Determine and advertise termination date of the 154 MHz system.
- ☐ Turn off 154 MHz radio system.